A further question of interest which may be asked is, To what extent does the moon figure in this rocket investigation? It should be understood, first, that calculations for minimum initial mass of rocket, which take account of both air resistance and gravity, have shown that, for an average velocity of ejection of gases from the rocket of 12,000 ft./sec., an initial mass of rocket of but 40 pounds is necessary for each pound mass given a sufficient velocity (acquired far above the dense part of the atmosphere) to escape from the earth's predominating gravitational attraction. Actual laboratory tests have produced an average speed of ejected gases of closely 8,000 ft./sec., and results from tests *in vacuo* indicate that this corresponds to a speed of 9,700 ft./sec., *in vacuo*. There is every reason to believe, from results so far obtained and from well-established theory, that a sufficiently high velocity can be secured, with a rocket which consists chiefly of propellant material.

The object of the work is, however, much more than the performance of some single spectacular stunt. It is the development of a new method, and although experience has shown that it is hopeless to discuss publicly all the matters which have been studied, both theoretically and experimentally, it is confidently predicted that this method will lead to achievements of the very greatest interest, which can almost certainly be realized in no other way.

New methods are usually slow of development, but it would be well worth while if the means were at hand to make an attack simultaneously upon all the problems connected with this investigation.

BIBLIOGRAPHY OF DR. W. DWIGHT PIERCE'S CONTRIBUTIONS ON METEOROLOGICAL EFFECTS ON LIFE

Dr. W. Dwight Pierce, consulting research director, Banning, Calif., has, during the last two years, published numerous articles dealing with physiological effects of air conditions. In response to a request Doctor Pierce has prepared the following bibliography of his papers, covering meteorological effects on life. Since most of the publications referred to are not usually brought to the attention of meteorologists, the publication of this bibliography should be of value to those studying the biological effects of air conditions.—*C. F. B.*

1. Some factors influencing the development of the boll weevil. Proc. Ent. Soc. Washington, vol. 13, pp. 111–114, discussion 114–117, June 19, 1911.

2. The insect enemies of the cotton boll weevil. W. Dwight Pierce, R. A. Cushman, and C. E. Hood, in U. S. Bureau of Entomology, Bul. 100, pp. 1–99, April 3, 1912. (3 plates, 26 figs.)

3. Mexican cotton boll weevil. W. D. Hunter and W. Dwight Pierce, Senate Document 305, 62d Congress, 2d session, pp. 1–188, 22 plates, 34 figs., April, 1912.

4. Note on temperature control. Proc. Ent. Soc. Washington, vol. 14, p. 87, June 19, 1912.

5. Note on classification of temperatures. Proc. Ent. Soc. Washington, vol. 14, pp. 101, 102, June 19, 1912.

6. A new interpretation of the relationships of temperature and humidity to insect development, Journ. Agric. Research, vol. 5, No. 25, pp. 1183–1191, figs. 1, 2, March 20, 1916. Abstracted in Mo. WEATHER REVIEW, U. S. Dept. of Agric., vol. 47, No. 7, July, 1919, pp. 494–495.

7. The relations of climate and life and their bearings on the study of medical entomology, in Sanitary Entomology (Richard G. Badge, publ., Boston, Mass., edited by W. Dwight Pierce), ch. 6, pp. 97–104, March 6, 1921.

Doctor Pierce says: "These articles trace the beginnings of the philosophy in my lecture on 'The Laws of Nature as Affecting Insect Abundance.'"

8. Air conditioning in hospital sanitation, printed in *The Nation's Health*, vol. 4, No. 7, pp. 444–446, July 15, 1922, and reprinted as "Bringing Climate to the Patient" in *The Modern Hospital*, vol. 19, No. 3, pp. 199–202, September 1, 1922; reviewed in *Literary Digest*, February 10, 1923, p. 27.

9. Air conditioning, longevity, and health, *The Nation's Health*, vol. 4, No. 9, pp. 563–566, September 15, 1922.

There is a series of articles running in *The Western Florist, Seedsman and Nurseryman*, printed in Los Angeles (315 South Broadway) on similar lines as applied to the plant: "Treating the plant as a living being" (April, 1923); "Nursery and greenhouse sanitation" (July, 1923); "Tackling difficult problems" (September, 1923); "Climate and the plant" (December, 1923); "Problems the date growers are trying to solve" (January, 1924).

10. The bearing of climate laws on plant and animal activity, appeared in *The Fruitman* (S. F.) Sept. and Oct., 1923.

WATERSPOUT AND TORNADO WITHIN A TYPHOON AREA

551.515 (51)

By Prof. GEORGE B. BARBOUR

[Department of Geology, Peking University, Peking, China]

A tornado in north China is sufficiently rare to merit comment, especially if it chooses its path right through the center of the principal summer resort of the entire foreign community north of Shangtung. Peitaiho Beach (39° 48′ N. lat., 119° 30′ E. long.) owes its popularity to the fact that it is the first point along the coast east of Tientsin where bedrock is exposed; all the shore to the west is part of the delta formation of the Bay of Peking upon which Tientsin itself is built.

On the afternoon of August 11, a tornado struck the shore and went inland crossing the foreign settlements at its widest point, seriously damaging all the buildings in its track. It showed the characteristics of those in more southerly latitudes. By good fortune the Italian gunboat *Sebastiano Caboto* was anchored almost in its track, and I am indebted to the careful observations of Capt. G. Viganoni for records he has most generously supplied. Also without the cooperation of Mr. R. D. Goodrich, jr., of Tientsin, I should have been entirely unable to secure other data regarding the occurrence.

Local opinion blames the "extra fifth month" intercalated in 1922 with the abnormal weather experienced since that date. In any case the winter and spring were the mildest in 15 years, the summer less hot and the period of autumn rain showers more than usually protracted. The general weather conditions have been unsettled and the damage by typhoons appears comparatively severe, though this latter is not so easy to estimate.

On August 10 the observatory at Siccawei [Zi-ka-wei] near Shanghai had simultaneous warnings out for two typhoons, one being eventually signaled from latitude 28° N. and longitude 122° E.

At 6 a. m. on the 11th it was reported moving north and described as of extreme violence. The local barometer readings at Peitaiho had stayed at 760 mm. (29.92 inches) until the afternoon of the 10th when the sky became overcast. Heavy rain fell during the latter hours of the night, the wind veered from southwest to northeast with the barometer steady at 759.5 mm. (29.90 inches.)

Soon after 1 p. m. the barometer began to fall, the wind veered sharply to west-southwest and increased to 25 f. p. s. (17 m. p. h.). Rain fell all afternoon with increasing violence, passing into a severe thunderstorm. A few minutes after 4 p. m. a brilliant flash of lightning was accompanied by a particularly loud thunderclap that shook the entire settlement.

At the same time about three-quarters of a mile out to sea, the formation of a whirl could be clearly seen.

The behavior was characteristic. Several observers from the shore speak of noticing two specially heavy clouds rush together and almost at once the formation of a waterspout. When it passed within 20 yards of the *caboto* its height was estimated at 50 feet. Calculations since show that the center of depression moved at about 6 miles an hour toward the northeast. The waterspout only twice linked up as an entire column and of course on striking the shore the characteristics of a whirlwind replaced those of the spout. But the subsequent track on land showed the typical erratic tortuous course, sometimes striking the ground with special violence, elsewhere hopping over a house untouched. The usual freakish

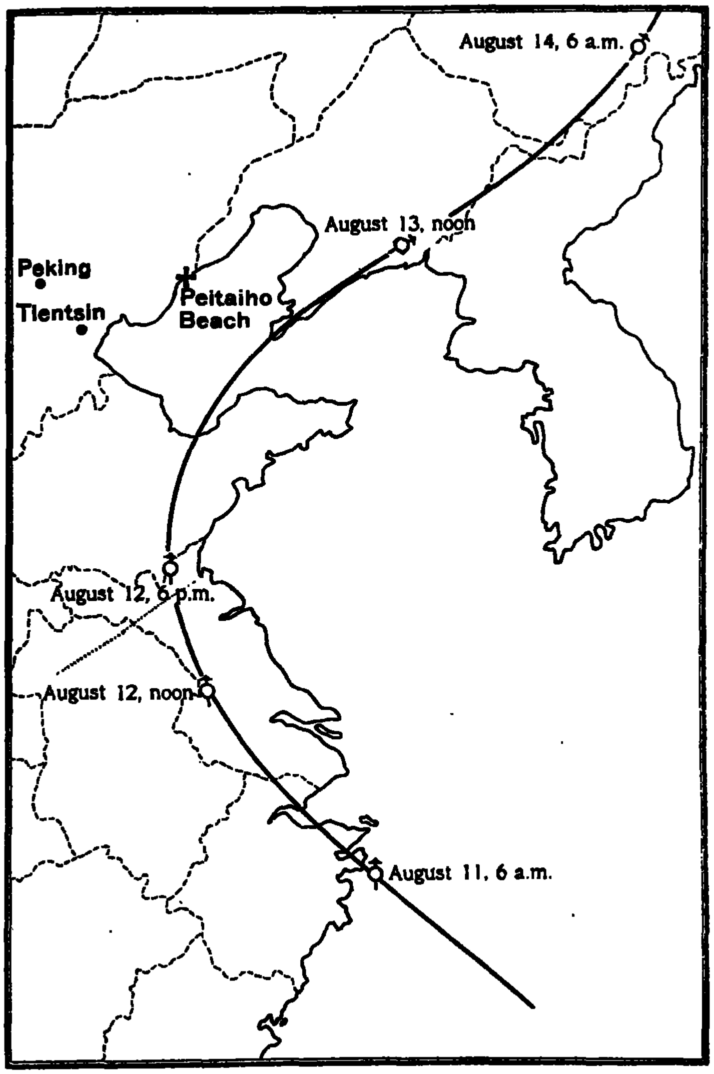

FIG. 1.—Track of Melacosima and China typhoon on Aug. 11-14, 1923

destruction of buildings occurred. Judging by the track left the central zone of the tornado was not much over 150 feet in diameter, its traces were visible at intervals over a distance of 5 miles inland, the last record being where it struck a sand dune one-quarter of a mile west of the military camp near Chinwangtao.

In almost all cases the damage to houses roofed with corrugated iron was much more severe than to tiled buildings. Typical examples are seen in the photographs (not reproduced). In one case a cement block weighing 140 pounds was carried clear over a house 20 feet high. Since the block carried one of the uprights supporting the roof, part of the surface of the latter took the lift, becoming detached in mid-air later.

After the passing of the tornado the wind swung back to northeast and fell to 6 f. p. s. (4.1 m. p. h.), but the barometer continued to fall. As the approach of the typhoon was feared, continuous barometer readings were taken on the *Caboto*. On the afternoon of the next day the pressure fell to 754 mm. (29.68 inches) when the center of the typhoon was located 150 miles to the SSW. By midnight the wind had risen and heavy rain fell with a further drop to 751 mm. (29.57 inches) which continued at a rate of 2 mm. per hour till a minimum of 747 mm. (29.41 inches) was recorded.

The centers of depression that pass north over to the Yellow Sea usually eventually swing NE. and this minimum barometer reading at 6 a. m. (corresponding to a distance of something less than 140 km. for the center of disturbance) indicates that the typhoon had already veered toward Port Arthur. Following this deflection to the NE. early on the 12th, conditions began to improve. By noon of August 13 normal weather was reestablished, at which time the typhoon was signaled from Port Arthur.

The tornado was thus probably a local disturbance produced in advance of the main depression, which was of an unusually persistent and violent character and showed little sign of breaking up even in Manchuria.

COMMENTS

The foregoing article by Professor Barbour reached the Weather Bureau through the instrumentality of Dr. C. F. Brooks, Clark University, Worcester, Mass. It forms a most interesting account of that rare phenomenon of nature— a secondary whirl that forms over the water but later reaches and traverses a land area, being in turn waterspout and tornado. Hann mentions one such whirl [1] and the phenomenon is described in full by Wegener.[2]

Meteorological records in America apparently furnish but one example of this type of secondary whirl. It occurred in southern Florida on September 10, 1919, during the passage of a West India hurricane, the center of which at the time was about 125 miles distant. According to R. W. Gray [3] Weather Bureau official at Miami, Fla., this whirl developed either over the ocean or Biscayne Bay, a shallow body of water at the mouth of the Biscayne River, and in its original form was undoubtedly a waterspout. It is generally known as the Goulds tornado on account of the damage it caused at a small town of that name, located about 20 miles southwest of Miami.—*F. G. T.*

The hurricane itself continued its westward movement across the Gulf of Mexico and entered the Texas coast near Corpus Christi on September 14, immediately losing its identity as a storm center. It was followed on the 15th and 16th by torrential rains in parts of Teaxs and New Mexico and on the 19th a small tornado occurred near the station of Hobbs, in the latter State. The path of this tornado, which was reported and described by Mr. E. H. Byers,[4] cooperative observer, was very narrow, probably at no time more than 100 yards wide, and had a length of about 1 mile. According to Mr. C. E. Linney, Weather Bureau section director for New Mexico, it was the first true tornado to be reported in the State. Since that time, however, two small tornadoes have been observed in New Mexico. While not occurring

[1] Hann's Lehrbuch, 3d ed., p. 726.
[2] A. Wegener, Wind -und Wasserhosen in Europa, pp. 29-31.
[3] Mo. WEATHER REV., Sept., 1919, 47: 639.
[4] MO. WEATHER REV., Sept., 1919, 47: 639. Ibid 51: 314.

until after the dissipation of the hurricane it is not improbable that the conditions induced by the latter were favorable for the formation of the tornado.

The typhoon that was in progress when the tornado described by Professor Barbour occurred was, according to the Rev. José Coronas, of the Philippine Weather Bureau, one of eight to visit the Far East in the month of August, 1923. It is known as the *Meiacosima and China Typhoon* and has been described by Father Coronas as follows:

The first part of the track of this typhoon is somewhat uncertain, although it probably formed on August 3 to 4 south of Guam near 145° longitude E. and 10° latitude N., moving northwestward until August 6 and then westward on the 7th and part of the 8th. The center can easily be situated in our weather map of the 8th, 6 a. m., near 130° longitude E., between 18° and 19° latitude N.; and at 6 a. m. of the 9th in about 127° longitude E., between 20° and 21° latitude N. The typhoon was moving then NNW. and so it struck the Meiacosima group of islands about 150 miles east of northern Formosa on the 10th. The station of Ishigakihima reported at 6 a. m. of that day a barometer as low as 722.5 mm. with hurricane winds from the N. From Meiacosima the typhoon inclined northwestward and entered China in the morning of the 11th between 27° and 28° latitude N. Once in China it moved again NNW., gradually recurving to the NE. on the 12th, and traversed Manchuria on the 13th.—EDITOR.

THE EYE OF THE STORM [1]

By DOUGLAS MANNING

[Alexandria Bay, N. Y.]

A rather interesting condition prevailed here yesterday morning, December 6, between 10 and 11:30 o'clock in the forenoon and, in my judgment, it was caused by the immediate passage of a vast low-pressure area centered over this vicinity, or in other words was the "eye of the storm."

At 7 o'clock in the morning when I stepped out of doors it was raining and the wind was blowing almost a whole gale out of the northeast, with the sky covered with dark masses of nimbuslike clouds moving out of the south-southwest and a low scud racing across it from the same direction as the wind or perhaps a point more from the east than the wind was. From then on the wind gradually diminished in force as a patch of blue sky that first appeared in the west approached and which appeared to occupy about a quarter of the sky, and from which the clouds seemed to melt and break away in all directions. As this clear area finally drifted overhead the wind died away completely making the surface of the St. Lawrence River, on the banks of which this village is situated, appear as a sheet of glass in sharp contrast to the white-capped waves kicked up by the northeast gale a short time before. At the same time the temperature which was standing around 36° F. rose to 44° F. and the sun came out making it feel like a day in Spring. Even the cirrus and heavy alto cumulus and stratus melted away in this area but all around us and especially to the west the sky was an angry black. I was sorry that I could not have observed my barometer at this time which read very low at 7 o'clock. This clear space soon passed over us followed by the wind suddenly coming out of the south and a heavy shower accompanied by a still further rise in temperature until the thermometer stood at 50°. After this the wind gradually got around to the southwest and began to blow around 30 to 35 miles per hour and with a drizzling rain and slowly falling temperature, with a tendency to blow in increasingly strong gusts. The cloud formation was that uniform grey seen at such times which is hard to classify otherwise than strato cumulus and nimbus which were moving from the southwest. This calm lasted about half an hour and to me was quite interesting.

[1] Mr. Manning's observations show the prevalence of a central core of calm in an intense extra-tropical cyclone that passed over his station as described. Reference to to the daily weather maps of the Weather Bureau show this cyclone to have had a small diameter and central pressure of 29.15 inches with a fully developed cyclonic circulation.—EDITOR.

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NOTES, ABSTRACTS, AND REVIEWS

A METHOD OF COMPUTING EVAPORATION FROM TEMPERATURE GRADIENTS IN LAKES AND RESERVOIRS [1]

By GEO. E. MCEWEN

[Author's abstract]

A satisfactory interpretation of observations on the distribution of temperature, salinity, and other properties of water in the ocean, lakes, or reservoirs demands the mathematical formulation and solution of certain ideal problems. Although "field" observations must underlie the development of appropriate ideal problems, methods similar to those of mathematical physics can be used in dealing logically with such data. Also, as far as practicable, use should be made of well-established principles of physics, based upon laboratory experiments, but the main purpose of it all is to coordinate observations of natural phenomena.

This paper presents certain results of attempting to coordinate the amount of radiant energy absorbed by fresh water, the heat removed by evaporation, the water temperatures at a series of depths, and the time rate of change of temperature at each depth. It does not present any explanation of the mechanism or cause of evaporation. The qualitative physical basis of the theory consists of the following fundamental assumptions:

1. Heat is supplied to the water at each level by the absorption of radiant energy according to the familiar exponential law. The rate at which heat energy is absorbed depends upon the amount penetrating the water surface, the distance below the surface, and the absorption coefficient.

2. At the surface thin volume elements are cooled by evaporation at a rate assumed to be uniform throughout the whole surface area under which the temperatures may be considered equal to those at the station where observations are made. But the actual reduction of temperature of any one element varies—that is, different elements are cooled for different lengths of time, and consequently have different temperatures and specific gravities before beginning their descent. Therefore, the greater the reduction of temperature, or the colder and heavier the elements are, the longer will be the time required to produce the change, and the less frequent will be their descent. Also the number of elements in a given area, having a given temperature reduction will be smaller the greater the amount of the reduction.

3. Each element descends to a depth at which the average (observed) specific gravity is slightly less than that of the descending particle—that is, equilibrium is approached but not completely attained. Consequently

[1] Original paper presented at meeting of American Meteorological Society at Lo Angeles. Calif.. Sept. 17-19, 1923.